

Climate Change in Central Ohio: Why We Should Act



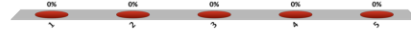
 **THE OHIO STATE UNIVERSITY**
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

 **THE CITY OF COLUMBUS**
MICHAEL B. COLEMAN, MAYOR
COLUMBUS
PUBLIC HEALTH

- Climate Change presentation has been given to audiences throughout Columbus, with two main goals:
 - 1) To provide residents of Columbus with information on the best available science around climate change
 - 2) To better understand what residents think about climate change and what they are willing to support when it comes to individual and community action
- In addition to providing information to audience members, the PowerPoint includes 6 interactive questions to get information on participants' knowledge and attitudes on climate change.
- The presentation is part of a larger research project which also includes:
 - 1) Random baseline telephone survey of 400 Columbus residents to determine climate change knowledge and attitudes
 - 2) Follow-up survey with volunteers 3-6 months after presentation to measure whether climate change knowledge and attitudes have changed as a result of the presentation

The “Greenhouse Effect” Refers To:

1. Pollution that causes acid rain
2. The Earth’s protective ozone layer
3. Gases in the atmosphere that trap heat
4. How plants grow
5. I am not sure



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



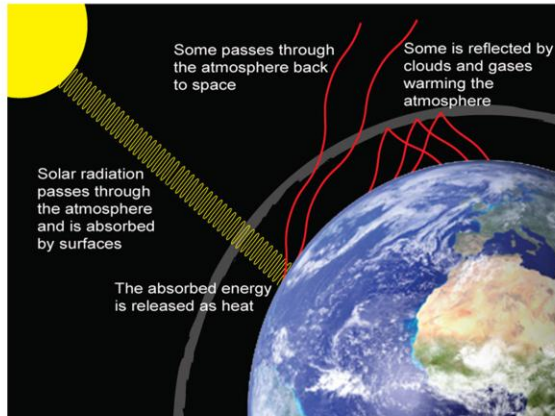
THE CITY OF COLUMBUS
MICHAEL B. COLUMBUS MAYOR
COLUMBUS
PUBLIC HEALTH

- Initial interactive question for audience participants.

Correct answer: 3

The Greenhouse Effect

- The sun generates light and heat
- Gases – like carbon dioxide - in the atmosphere trap heat
- This effect allows Earth to support life
- Isn't this good?
 - Too many gases equals too much heat



Note 1. IPCC glossary, 2013



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

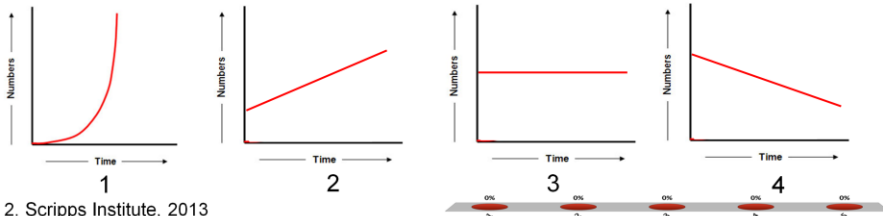


Explanation of Greenhouse Effect:

- The greenhouse effect occurs when gases in our atmosphere act as a blanket to trap and hold the sun's heat
- Without this blanket, much of the sun's heat would simply be reflected back out into space and the earth would not support life
- Greenhouse Effect is a natural and beneficial phenomena.
- But too much of a good thing can be a bad thing.
- We'll talk more about this as the presentation continues.

Since 1850, the amount of greenhouse gases (such as carbon dioxide) in the atmosphere have been...

1. Rapidly increasing
2. Steadily increasing
3. Staying the same
4. Steadily decreasing
5. I am not sure



Note 2. Scripps Institute, 2013



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

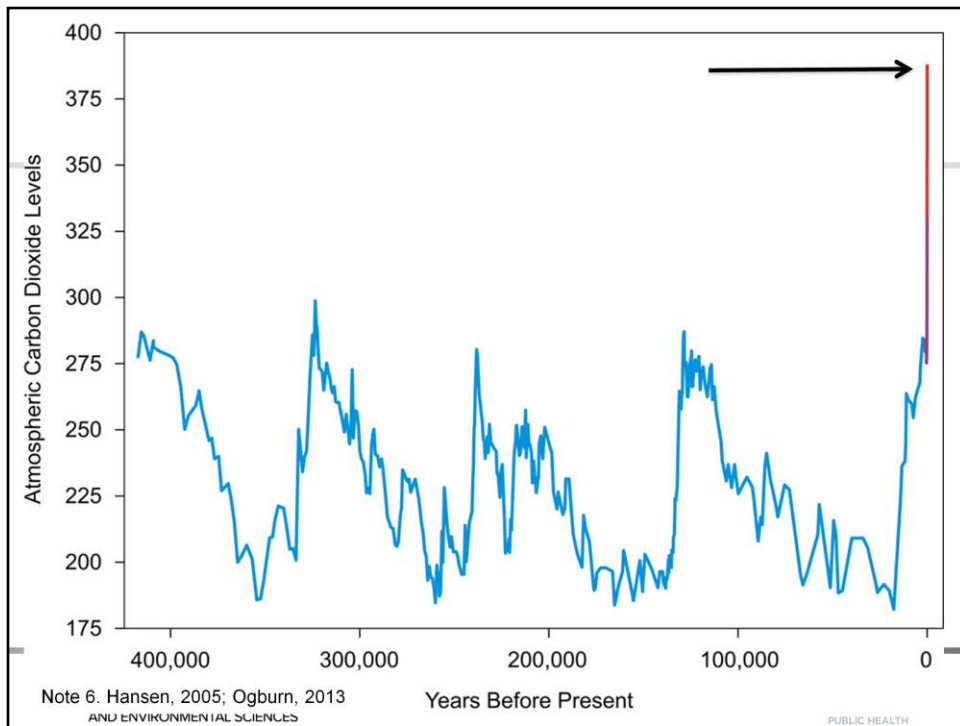


COLUMBUS
PUBLIC HEALTH

- Second interactive question for the audience on what we've observed about the levels of one greenhouse gas: carbon dioxide

Correct answer: 1

- The amount of greenhouse gasses – specifically CO₂ – in the atmosphere has been rapidly increasing in the past 160 years or so.
- Why is this important? Because there is a strong correlation between CO₂ (and other greenhouse gasses) and temperature.



- This graph shows CO₂ levels over the last 400,000 years.
- Two important takeaways from the graph:
 - 1) Over the past 400,000 years, CO₂ levels have ranged in a fairly narrow band – between 175 parts per million (PPM) and 300 PPM.
 - 2) Until about the time of the Industrial Revolution, when CO₂ concentrations began rising very, very rapidly (note red line at right).
- We just recently crossed the 400 ppm threshold, which is higher than it's been for about 3.6 million years [*referenced under "Note 6"*]
- As mentioned earlier, this is significant because temperature correlates very strongly with CO₂ over this long time span.
- And if you look at recent temperatures:
 - Every decade since 1970 has been warmer than the previous decade, and
 - 2012 was the hottest year on record in the Continental US
- This current temperature change is happening much more quickly and to a greater

extent than any fluctuations we've seen in the past.

Climate change is real

- Weather - what's happening right now
 - It is cold today in Columbus!
- Climate - general weather characteristics of a region
 - Ohio is typically cold in the winter!
- Climate change - trends in the weather observed in a region over a long period
 - Ohio winters are getting warmer!



- So, greenhouse gas increases (like CO₂) mean temperature increases.
- But what does this have to do with weather and climate? It's important to understand the difference – the two terms are not inter-changeable and mean something very different.
- “Weather” is what’s happening at a given point in time – right now, or on any given day. “Climate” is the general weather characteristics of a region over a long period – usually 30 years or more.
- “Climate Change” is the change observed in a region’s weather characteristics over time.
- No matter what a region’s climate is, weather in that region can still vary. It can be unusually warm, cold, wet, etc., on any particular day. But a region’s climate is generally consistent over time – depending on the location, season, etc.
- “Climate Change” is the idea that we’re now seeing changes over what we’ve observed in the past. Though individual days in a region can vary, areas across the

globe are warmer than they've been historically.

Climate change is real

- Global temperatures have been generally stable
 - In the last 10,000 years, global average temperatures ranged only 2° F warmer or 2° F cooler than today
- But small changes = BIG impacts
 - 20,000 years ago, global average temps were about 9° F cooler than today – and that caused the Ice Age!

Note 3. Hansen et al., 2012



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

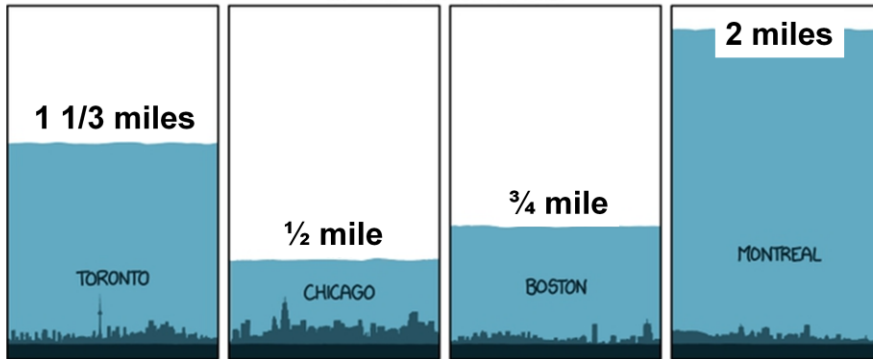


COLUMBUS
PUBLIC HEALTH

- So if regional weather and short term temperatures can fluctuate, why does it matter if we're seeing an overall increase in global temperature?
- Because global temperatures have been fairly stable across time.
 - Over the past 10,000 years, the average global temperature has only ranged about 2 degrees warmer or cooler than today.
- But small changes in temperature can have big impacts.
 - For example, 20,000 years ago the average global temperature was only 9 degrees cooler than today, and that caused the Ice Age.
- And the impact of that 9-degree change.....?

Climate change is real

THICKNESS OF THE ICE SHEETS AT VARIOUS LOCATIONS 21,000 YEARS AGO COMPARED WITH MODERN SKYLINES



Note 4. Dyke et al., 2002



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

THE CITY OF COLUMBUS
MICHAEL B. COLUMBUS MAYOR
COLUMBUS
PUBLIC HEALTH

- Ice sheets ranging from 1/2 mile thick in Chicago, to over 2 miles thick in Montreal – all because of a global temperature drop of 9 degrees

Climate change is real

- Global temperatures have been generally stable
 - In the last 10,000 years, global average temperatures ranged only 2° F warmer or cooler than today
- But small changes = BIG impacts
 - 20,000 years ago, global average temps were about 9° F cooler than today – and that caused the Ice Age!
- Global temperatures today are less stable
 - In the last 250 years, global average temps have already increased almost 1.5° F – that is fast warming!

Note 5. Hansen et al., 2010



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES





COLUMBUS
PUBLIC HEALTH


- Today we're seeing global temperatures that are less stable than in the past.
- In the past 250 years, the average global temperature has already increased 1.5 degrees
- This is tremendously fast warming compared to what we've seen historically.
- This very sudden, very rapid change in global temperature makes it extremely difficult for our natural systems – and the life supported by them – to adapt.

Which comes closest to your own view?
Among the world's scientists...

1. Most think climate change is caused by humans.
2. There is a lot of disagreement over whether or not climate change is caused by humans.
3. Most think climate change is not caused by humans.
4. I am not sure.



 **THE OHIO STATE UNIVERSITY**
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

 **THE CITY OF COLUMBUS**
MICHAEL B. COLUMBUS MAYOR
COLUMBUS
PUBLIC HEALTH

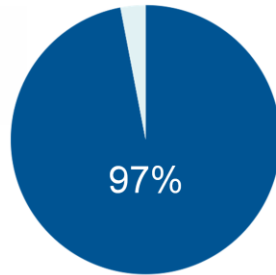
- Third interactive question that explores what people think about the cause of climate change....

Correct answer: 1

Climate change is real and caused by people

Based on the evidence, 97% of climate scientists have concluded that human-caused climate change is happening.

American Association for the Advancement of Science



Note 7.



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



- In fact, 97% of climate scientists believe that climate change is happening and is caused by humans.
- Is there some disagreement? Yes.
- But the disagreement among scientists is about the range and severity of these climate change impacts, not about whether climate change is happening or is caused by people.
- The Earth's temperature can get warmer from natural factors.
- But size and rate of what we're seeing can't be explained by natural factors alone.
- It can only be explained by accounting for the levels of heat-trapping greenhouse gasses we're putting in the atmosphere.

Climate change is real and caused by people

Pentagon, CIA Eye New Threats

Climate Change & The Environment

As one of the largest electric utilities in the United States and a large consumer of fossil fuels, we know the impact our operations have on the environment. Climate change may be one of the most significant sustainability issues for AEP and one of our most challenging.

Our position on climate change remains unchanged: We believe it is a global issue that requires a global solution. Today there are no mandates to drive new investments in technologies that address carbon dioxide emissions. Consequently, we can only focus on what we can change and can afford.





THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



COLUMBUS
MICHAEL B. COLUMBUS M.D.
COLUMBUS
PUBLIC HEALTH

- This belief isn't confined to narrow scientific circles...numerous other organizations share this belief.
- All national academies of sciences in 32 nations
- Every major scientific organization whose members include climate scientists – including the American Association of Petroleum Geologists
- Every major religious denomination with a climate change statement except the Southern Baptist Convention
- The Pentagon, major corporations, utility companies, and on....

Which of the following, if any, contributes to climate change (Select all that apply)

1. Aerosol spray cans
2. The hole in the ozone layer
3. Burning fossil fuels for heat and electricity
4. Powering cars and trucks
5. Cows and other livestock
6. Cutting down forests
7. Toxic wastes
8. Nuclear power plants
9. None because climate change is not happening



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



COLUMBUS
PUBLIC HEALTH

- Fourth interactive question about what human actions contribute to production of greenhouse gases, and ultimately, global warming.

Correct answers: 3,4,5,6

Climate change is real and caused by people

- The burning of fossil fuels (coal, oil) produces carbon dioxide:
 - Transportation (cars, buses, planes)
 - Energy production (electricity, heating/cooling)
- Industry (manufacturing/production) produces methane
- Cutting down forests reduces the carbon storage capacity of the Earth



Note 8. US EPA, 2013



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES




COLUMBUS
PUBLIC HEALTH


- One of the biggest contributors is the burning of fossil fuels
- These fuels – oil and coal – release greenhouse gas...the most significant being CO2.
- The largest sectors that produce these gasses are the transportation and energy production sectors.
- Other big contributors are the manufacturing / production sector which produces methane – another significant greenhouse gas.
- Other contributing factors to greenhouse gas increases include the removal of Earth's natural systems (like forests), that actually trap greenhouse gasses and prevent them from being released into the atmosphere.

Climate change will result in more of the following health problems... (Select all that apply)

1. Diabetes
2. Cancer
3. Asthma
4. Tuberculosis
5. Insect-borne disease (e.g., West Nile Virus)
6. Heat stroke
7. Storm-related injures/deaths
8. None because climate change is not happening

0% 0% 0% 0% 0% 0% 0% 0%

 **THE OHIO STATE UNIVERSITY**
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

 **THE CITY OF COLUMBUS**
MICHAEL B. COLUMBUS MAYOR
COLUMBUS
PUBLIC HEALTH

- Fifth interactive question that explores how climate change affects human health.

Answers: 3, 5, 6, 7

Climate change is bad for Ohio

Extreme weather

- More severe heat and related air quality issues
- Stronger, more frequent storms: blizzards, floods, tornados, straight line winds, etc.

Note 9. US Global Change Research Program, 2009; Climate Change Science Program, 2008; USEPA 2010

The Columbus Dispatch

Midwest could see damaging winds from derecho Tuesday June 11, 2013 5:00 PM



This house at the intersection of Milton Avenue and Montrose Way in Clintonville was hit by a fallen tree during a June 2012 storm, with a significant portion of it on top of the house. Courtney Hergesheimer | Dispatch



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



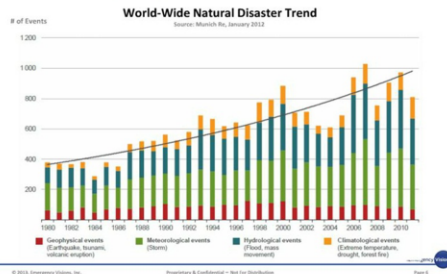
- One of the biggest impacts for us will be more extreme weather.
 - More extreme heat, and with that, poorer air quality.
 - Poor air quality increases the risk of more asthma attacks for current sufferers.
 - And more people being diagnosed with the disease.
 - Extreme weather also increases the risk of death and injury from stronger, more frequent and more severe storms
- Rising temperatures are already changing weather patterns – producing more extreme weather.
- These extreme weather events are likely to continue.

2012-2014 Top 10 Hazards for Franklin County

1. **Tornado**
2. **Dam Failure**
3. **Flooding**
4. WMD Terrorist Incident
5. Cyber-Terrorism
6. **Infectious Disease**
7. **Severe Winter Weather**
8. Hazardous Material Incident
9. Transportation Accident – Aircraft
10. **Severe Summer Weather**

New Normal

- Disasters are getting worse



Source: Franklin County Emergency Management and Homeland Security



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



THE CITY OF COLUMBUS
MICHAEL B. COLUMBUS MAYOR
COLUMBUS
PUBLIC HEALTH

- We see some evidence of this from various sources.
- Insurance companies are obviously very interested in extreme weather events.
 - Reference information from Munich Re (chart at right) concerning world-wide disaster trends since 1980.
- Reference (at left) emergency preparedness work by Columbus Public Health and Franklin County EMA identifying “Top 10” Franklin County hazards.
 - 5 of the 10 are related to extreme weather
 - A 6th – Infectious Disease – is also related to climate change

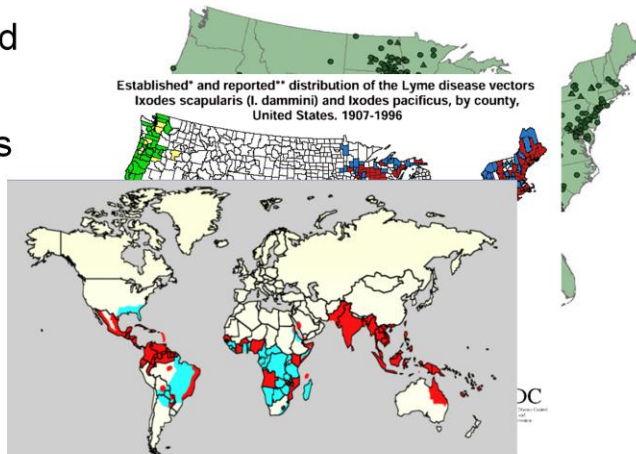
Climate change is bad for Ohio

Insect-transmitted disease

- West Nile Virus
- Lyme Disease
- Dengue Fever

Note 10. Confalonieri et al., 2007

Note 11. Maps



 **THE OHIO STATE UNIVERSITY**
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

 **THE CITY OF COLUMBUS**
MICHAEL B. COLUMBUS MAYOR
COLUMBUS
PUBLIC HEALTH

- As the climate warms, there will be an increased risk of diseases being transmitted by insects and other organisms.
- As temperatures increase, insect habitats will increase as areas that were once too cold are now warm enough to support them.
- This means more habitat and a greater range for mosquitos and the possible spread of diseases like West Nile.....
- Greater habitat and more range for ticks, and the possible spread of Lyme Disease....
- And even the introduction of diseases not historically seen in U.S. – like Dengue Fever, which is spread by a species of mosquito native to tropical regions.

Climate change is bad for Ohio

Vulnerable populations most at risk:

- The poor, the very young and very old
- Those with mental and physical handicaps
- Those with chronic health conditions



Note 9.



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



- Although climate change impacts will be experienced by all of us, many of the consequences will be disproportionately felt by our most vulnerable populations:
 - The poor, the very young and very old
 - The handicapped
 - Those with existing chronic health conditions

How high is too high?



1.5° – Observed warming since the pre-industrial age (about 1800)

Note 5. Hansen et al., 2010



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

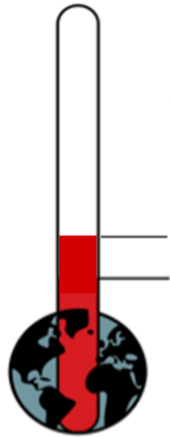


COLUMBUS
PUBLIC HEALTH

If climate change is real and caused by people, and will have serious impacts – how high is too high? How high do temperatures have to go before we should be worried?

- As we noted earlier, temperatures have been fairly stable for the past 10,000 years. All of human civilization has developed in a narrow band of stable temperatures – plus or minus 2 degrees.
- In the past 200 years or so, however, the average global temperature's risen about 1.5 degrees.
- And as we've said with the Ice Age example, little changes can have big impacts.

How high is too high?



3.6° – The threshold of danger
1.5° – Observed warming since the pre-industrial age (about 1800)

Note 12. den Elzen and Meinshausen, 2005; Rogeli et al., 2009

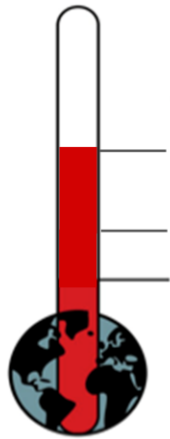


THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



- The typical answer to the question of “How high is too high?” has been 3.6° F over pre-industrial levels.
- This number was identified and generally accepted by climate scientists in the early 1990s as the number to avoid to prevent “dangerous” climate change.
- Unfortunately, scientists are now finding that the negative impacts associated with at 3.6° increase are actually happening at earlier levels than expected and...

How high is too high?



7.2° – 2100 Projection

3.6°

- Highest temps in 30 million years
- Sea level rise of 3-6 feet

1.5°

- Drought on 40% of inhabited land
- Half of known species extinct

Note 13. Potsdam Institute for Climate Impact Research and Climate Analytics, 2012



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



COLUMBUS
PUBLIC HEALTH

- That it's generally accepted now that we'll cross 3.6° threshold.
- In fact, many scientists feel temperatures will pass the 4 degree threshold unless there's a sudden, huge and organized global effort to affect change.
- Without such an effort, many scientists feel the global temperatures could actually increase between 5.5 and 7.2 degrees by 2100.
- Note the potential impacts if a 7.2-degree increase would actually occur.
- To illustrate – a sea level increase of 3 to 6 feet would cover the Outer Banks in North Carolina, many of our coastal cities.
- Even areas not directly affected by sea level rise would be indirectly affected as displaced populations migrate to more secure locations.
- These impacts can't be certain (remember that scientific models and resulting predictions can't be certain), but a warming increase of this magnitude would

undoubtedly have tremendous consequences.


Can we do anything about it?




All very sobering....but the good news is that we can do something about it!


Which of the following actions do you think would reduce climate change? (Select all that apply)

1. Switching from fossil fuels to renewable energy
2. Increasing public transportation
3. Planting trees
4. Reducing toxic waste (nuclear, chemical)
5. Banning aerosol spray cans
6. Improving building insulation
7. Eating less beef
8. None because climate change is not influenced by humans
9. None because climate change is not happening





THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

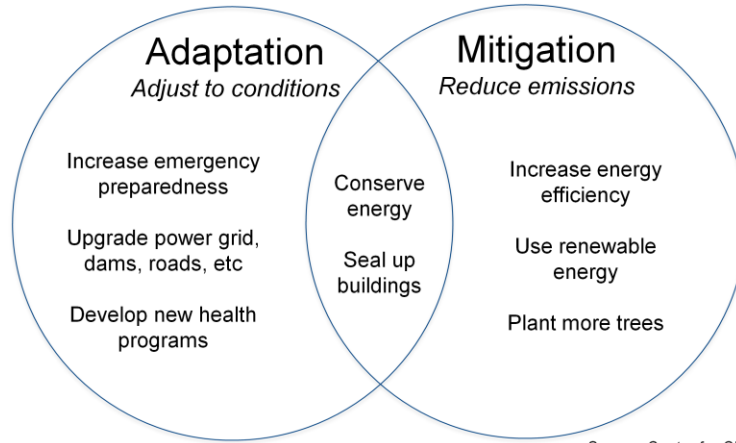


THE CITY OF COLUMBUS
MICHAEL B. COLUMBUS MAYOR
COLUMBUS PUBLIC HEALTH

- Final interactive question to explore actions that can reduce climate change.

Correct answers: 1, 2, 3, 6, 7

We can do something about it!



Source: Center for Clean Air Policy



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



COLUMBUS
PUBLIC HEALTH

- Communities and individuals can recognize the reality of climate change and begin making changes using two types of strategies.
- The first involves reducing our greenhouse gas emissions. This type of strategy is called **mitigation**. It generally involves reducing our fossil fuel consumption, conserving natural resources and maintaining or adding natural systems that absorb and trap greenhouse gases like CO₂ and prevent them from being released into the atmosphere. Our oceans and forests are two examples of systems that trap and store large amounts of CO₂.
- The second type of strategy is adaptation, where society prepares for and adjusts to climate change impacts.
- Adaptation strategies could include breeding more heat-and-drought resistant crops, preparing for more storm-surge flooding, and building more water storage capacity.
- Some actions – like conserving energy and sealing buildings – could be examples of both strategies.

“We” are doing something about it!

- Conversion of city vehicle fleet to alternative fuels
- Commitment to “green building” for city facilities
- Residential recycling and bike sharing programs
- Expansion of regional bikeway network
- Expanding the city’s tree canopy
- And more!
 - Go to: Columbus.gov/GetGreen



- The City of Columbus is already taking significant steps to reduce the city’s carbon footprint and production of greenhouse gasses, which also comes at a costs savings to the people of Columbus.
- Note the examples of city actions.
- Moving forward, the city is interested in thinking about how it can better adapt to the changing conditions and prepare for some of the predicted health impacts.

You can do something about it!

Action	Carbon reduced (lbs/yr)*	Money saved (\$\$/yr)*
Around your house...		
- Turn down your heat 5° at night	1148	\$107
- Keep your house 5° warmer in the summer	1646	\$43
- Wash clothes with cold water (5 loads/wk)	425	\$32
Around your garage...		
- Reduce miles by 10 per week	531	\$85
- Do regular maintenance (e.g., tires inflated)	1784	\$248
TOTALS	5534	\$515

Source: US EPA Household Carbon Footprint Calculator

*Based on an average US family of 4 and 83,000 pounds of CO2 emissions per year



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



THE CITY OF COLUMBUS
MICHAEL B. COLUMBUS MAYOR
COLUMBUS
PUBLIC HEALTH

- As an individual, the biggest thing you can do is to increase your home's energy efficiency.
- This not only helps reduce greenhouse gasses (mitigation) that contribute to climate change, but it also saves you money!
- For example, heating and air conditioning draw more than half the energy a U.S. home uses.
- You can also change the way you travel, as cars produce over 20% of total carbon emissions in the United States.

You can do something about it!



SPOTlight
GREEN
YOUR WORLD
CONTACT

LEARN

JOIN

SHARE

WELCOME TO THE SPOT WHERE COLUMBUS GETS GREEN

You're taking the first step to making your home, business, or community group part of a cleaner, healthier, more sustainable Columbus.

We're glad you're here.

[LEARN MORE](#) / [REPLAY VIDEO](#) / [A MESSAGE FROM MAYOR COLEMAN](#)





THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



THE CITY OF COLUMBUS
MICHAEL B. COLEMAN, MAYOR
COLUMBUS
PUBLIC HEALTH

For more assistance from the of City of Columbus about “going green” you can check out www.columbusgreenspot.org

Takeaways for today

- Climate change is real
- Current climate change is caused by people
- Climate change is having (and will have) negative impacts on people in Columbus
- We can do (and are doing) something about it!
- Thank you!
 - For more information contact Richard Hicks
 - Email: rickh@columbus.gov, Phone: (614) 645-6189



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



THE CITY OF COLUMBUS
MICHAEL B. COLUMBA, MAYOR
COLUMBUS
PUBLIC HEALTH

- We hope that you found this presentation interesting and informative, and that you'll remember the 4 take-aways above.
- If your community group would like to schedule a presentation, or if you'd like more information, contact Richard Hicks.

Notes and References

1. "Greenhouse gases effectively absorb thermal infrared radiation, emitted by the Earth's surface, by the atmosphere itself due to the same gases, and by clouds. Atmospheric radiation is emitted to all sides, including downward to the Earth's surface. Thus greenhouse gases trap heat within the surface-troposphere system. This is called the greenhouse effect. Thermal infrared radiation in the troposphere is strongly coupled to the temperature of the atmosphere at the altitude at which it is emitted. In the troposphere, the temperature generally decreases with height. Effectively, infrared radiation emitted to space originates from an altitude with a temperature of, on average, -19°C , in balance with the net incoming solar radiation, whereas the Earth's surface is kept at a much higher temperature of, on average, $+14^{\circ}\text{C}$. An increase in the concentration of greenhouse gases leads to an increased infrared opacity of the atmosphere, and therefore to an effective radiation into space from a higher altitude at a lower temperature. This causes a radiative forcing that leads to an enhancement of the greenhouse effect, the so-called enhanced greenhouse effect." **Annex II Glossary. Intergovernmental Panel on Climate Change.** http://www.ipcc.ch/publications_and_data/ar4/syr/en/annexes/glossary-e-i.html, Retrieved 08 October 2013.
2. " CO_2 concentrations measured from ice collected at Law Dome glacier in the Antarctic show that atmospheric CO_2 has been remarkably constant at about 270 to 280 ppm over about the last 1000 years until the 18th century when it began to rise. As of 2005, the level had risen to 378 ppm, an increase of 35%. On the basis of ice core records the current CO_2 concentrations are unprecedented for at least the last 650,000 years." **Scripps Institute of Oceanography CO_2 Program.** <http://scrippsco2.ucsd.edu/faq/faq.html>, retrieved 08 October 2013.
3. Temperatures were about 9 degrees F cooler 20,000 years ago during the last glacial maximum. Hansen, JE and Sato, M, Berger, A, Mesinger, F, and Sijacki, D, 2012. **Paleoclimate implications for human-made climate change**, Springer.
4. Ice was several miles thick over what are now large North American cities. Dyke, A, Andrews JT, Clark PU, England J, & Miller G, 2002. **The Laurentide and Innuitian Ice Sheets During the Last Glacial Maximum**, Quaternary Science Reviews, Vol. 21, pp. 9-31.
5. Temperatures have increased 1.5 degrees F in past 250 years. Hansen, J, Ruedy, R, Sato, M, and Lo, K, 2010: **Global surface temperature change**, Rev. Geophys. 48, RG4004.
6. CO_2 is much higher than in the past 400,000 years or more. i. Hansen, Climate Change, Vol. 68, 269, 2005. ii. Ogburn, Scientific American, May 10, 2013: <http://www.scientificamerican.com/article.cfm?id=ice-free-arctic-in-pleistocene-last-time-co2-levels-above-400ppm>, accessed 10/09/2013.
7. 97% of climate scientists agree that global warming is happening and that people have something to do with it. i. WRL Anderegg, "Expert Credibility in Climate Change," Proceedings of the National Academy of Sciences Vol. 107 No. 27, 12107-12109 (21 June 2010); DOI: 10.1073/pnas.1003187107. ii. P. T. Doran & M. K. Zimmerman, "Examining the Scientific Consensus on Climate Change," Eos Transactions American Geophysical Union Vol. 90 Issue 3 (2009), 22; DOI: 10.1029/2009EO030002. iii. N. Oreskes, "Beyond the Ivory Tower: The Scientific Consensus on Climate Change," Science Vol. 306 no. 5702, p. 1686 (3 December 2004); DOI: 10.1126/science.1103618.



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



COLUMBUS
PUBLIC HEALTH

Notes and References, cont.

8. Sources of greenhouse gases include transportation, energy production, industry, and deforestation. **US EPA.**
<http://www.epa.gov/climatechange/ghgemissions/sources.html>, accessed 10/09/2013

9. Heat-related deaths; increased frequency, duration and severity of heat waves; greater numbers of ticks and mosquitoes surviving in winter; increasing spread of West Nile Virus and Lyme Disease; more frequent and intense heat waves will increase likelihood of ozone formation. **USGCRP (2009). Global Climate Change Impacts in the United States . Karl, T.R., J. M. Melillo, and T. C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.** Heat waves, heat stroke and dehydration; young children, older adults, people with medical conditions, and the poor are more vulnerable than others to heat-related impacts. i. **USGCRP (2009). Global Climate Change Impacts in the United States . Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.** ii. **CCSP (2008). Analyses of the effects of global change on human health and welfare and human systems . A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors). U.S. Environmental Protection Agency, Washington, DC, USA.** Impacts on air quality: as of 2008, 126 million Americans lived in counties that don't meet National Air Quality Standards. Warmer temperatures will increase the frequency of days with unhealthy levels of ground-level ozone and smog. i. **CCSP (2008). Analyses of the effects of global change on human health and welfare and human systems . A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors). U.S. Environmental Protection Agency, Washington, DC, USA.** ii. **EPA (2010). Our Nation's Air: Status and Trends Through 2008 (PDF). U.S. Environmental Protection Agency. EPA -454/R -09-002.** Ground-level ozone is harmful to lung tissue, can reduce lung function and inflame airways, can increase respiratory symptoms and aggravate asthma. Especially harmful to children, older adults, outdoor workers and those with lung diseases. **NRC (2010). Adapting to the Impacts of Climate Change . National Research Council. The National Academies Press, Washington, DC, USA.** Climate change likely to increase levels of number of days with poor air quality...possible 68% increase in number of "unhealthy for everyone" air quality days in 50 largest U.S. cities by 2050. **USGCRP (2009). Global Climate Change Impacts in the United States . Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.** Worsening air quality will lead to more fine particulates in the atmosphere, from power plants gas and diesel engines, fires, high-temperature industrial processes – inhaling can lead to premature mortality, aggravation of cardiovascular and respiratory diseases, development of chronic lung diseases, exacerbation of asthma, decreased lung function and growth in children. **EPA (2009). Integrated Science Assessment for Particulate Matter: Final Report . U.S. Environmental Protection Agency, Washington, DC, USA**



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



COLUMBUS
PUBLIC HEALTH

Notes and References, cont.

Changes in allergens....spring pollen season earlier in year as climate warms and season longer because of rising temperatures. Also facilitation of more ragweed. i. USGCRP (2009). *Global Climate Change Impacts in the United States*. Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA. ii. CCSP (2008). *Analyses of the effects of global change on human health and welfare and human systems*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors). U.S. Environmental Protection Agency, Washington, DC, USA. iii. Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward (2007). Human health. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change iv. Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, (eds.), Cambridge University Press, Cambridge, United Kingdom. Heavy rainfall or flooding can increase water-borne parasites such as *Cryptosporidium* and *Giardia* that are sometimes found in drinking water. These parasites can cause gastrointestinal distress and in severe cases, death. USGCRP (2009). *Global Climate Change Impacts in the United States*. Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

10. The geographic range of ticks that carry Lyme disease is limited by temperature. As air temperatures rise, the range of these ticks is likely to continue to expand northward. Typical symptoms of Lyme disease include fever, headache, fatigue, and a characteristic skin rash. i. Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward (2007). Human health. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. ii. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, (eds.), Cambridge University Press, Cambridge, United Kingdom. In 2002, a new strain of West Nile virus, which can cause serious, life-altering disease, emerged in the United States. Higher temperatures are favorable to the survival of this new strain. USGCRP (2009). *Global Climate Change Impacts in the United States*. Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



COLUMBUS
PUBLIC HEALTH

Notes and References, cont.

11. West Nile Map: http://commons.wikimedia.org/wiki/File:West_Nile_Virus_Map-United_States_2012.jpg; Lyme Disease Map: <http://www.azlyme.org/diagnosis.htm>; Dengue Map: http://en.wikipedia.org/wiki/Dengue_fever
12. Avoiding the worst effects of climate change means keeping overall warming below 3.6 degrees F (2 degrees C). i. den Elzen M, Meinshausen M. (2005). Netherlands Env. Assessment Agency. Meeting the EU 2° C climate target: global and regional emission implications. ii. Rogelj, J.; Hare, B.; Nabel, J.; Macey, K.; Schaeffer, M.; Markmann, K.; Meinshausen, M. (2009). Halfway to Copenhagen, no way to 2° C. Nature Reports Climate Change.
13. The world is on course for a projected 7.2 degrees F of warming by 2100, assuming business as usual. Potsdam Institute for Climate Impact Research and Climate Analytics, <http://www.climateanalytics.org/sites/default/files/attachments/publications/Turn%20down%20the%20heat%2011-16-12.pdf>, accessed 10/09/2013.



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



COLUMBUS
PUBLIC HEALTH